Abstract Submitted
for the DFD16 Meeting of
The American Physical Society

The orientation field of fibers advected by a two-dimensional chaotic flow BARDIA HEJAZI, Wesleyan University, BERNHARD MEHLIG, University of Gothenburg, GREG VOTH, Wesleyan University — We examine the orientation of slender fibers advected by a 2D chaotic flow. The orientation field of these fibers show fascinating structures called scar lines, where they rotate by π over short distances. We use the standard map as a convenient model to represent a time-periodic 2D incompressible fluid flow. To understand the fiber orientation field, we consider the stretching field, given by the eigenvalues and eigenvectors of the Cauchy-Green strain tensors. The eigenvector field is strongly aligned with the fibers over almost the entire field, but develops topological singularities at certain points which do not exist in the advected fiber field. The singularities are points that have experienced zero stretching, and the number of such points increases rapidly with time. A key feature of both the fiber orientation and the eigenvector field are the scar lines. We show that certain scar lines form from fluid elements that are initially stretched in one direction and then stretched in an orthogonal direction to cancel the initial stretching. The scar lines that satisfy this condition contain the singularities of the eigenvector field. These scar lines highlight the major differences between the passive director field and the much more widely studied passive scalar field.

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Date submitted: 01 Aug 2016 Electronic form version 1.4